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**Northwest
Fisheries
Science Center**

Effects of vessels on southern resident killer whale behavior

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West Coast Marine Mammal Program Review
July 2015

Vessel Presence




Studies that addressed management needs relevant to proposed vessel regulations

Voluntary Guidelines

Be Whale Wise

Guidelines for watching marine wildlife



Whale Watching:

1. BE CAUTIOUS and COURTEOUS: approach areas of known or suspected marine mammal activity with extreme caution. Look in all directions before planning your approach or departure.
2. SLOW DOWN: reduce speed to less than 7 knots when within 400 metres/yards of the nearest whale. Avoid abrupt course changes.
3. AVOID approaching closer than 100 metres/yards to any whale.
4. If your vessel is unexpectedly within 100 metres/yards of a whale, STOP IMMEDIATELY and allow the whales to pass.
5. AVOID approaching whales from the front or from behind. Always approach and depart whales from the side, moving in a direction parallel to the direction of the whales.
6. KEEP CLEAR of the whales' path. Avoid positioning your vessel within the 400 metre/yard area in the path of the whales.
7. STAY on the OFFSHORE side of the whales when they are traveling close to shore. Remain at least 200 metres/yards offshore at all times.
8. LIMIT your viewing time to a recommended maximum of 30 minutes. This will minimize the cumulative impact of many vessels and give consideration to other viewers.
9. DO NOT swim with or feed whales.

Seals, sea lions and birds on land:

1. AVOID approaching closer than 100 metres/yards to any marine mammals or birds.
2. SLOW DOWN and reduce your wake/wash and noise levels.
3. PAY ATTENTION and back away at the first sign of disturbance or agitation.
4. BE CAUTIOUS AND QUIET when around haul-outs and bird colonies, especially during breeding, nesting and pupping seasons (generally May to September).
5. DO NOT swim with or feed any marine mammals or birds.

Viewing wildlife within Marine Protected Areas, Wildlife Refuges, Ecological Reserves and Parks:

1. CHECK your nautical charts for the location of various protected areas.
2. ABIDE by posted restrictions or contact a local authority for further information.

To report a marine mammal disturbance or harassment:

Canada:
Fisheries and Oceans Canada:
1-800-465-4336

US:
National Marine Fisheries Service
Office for Law Enforcement: 1-800-853-1964

To report marine mammal sightings:

BC Cetacean Sightings Network
www.wildwhales.org or (604) 659-3429

The Whale Museum Hotline
(WA state): 1-800-562-8832 or hotli.net@whalemuseum.org

OrcaNetwork
info@orcainetwork.org

Need more information?

Canada:
Fisheries and Oceans Canada
www.pac.dfo-mpo.gc.ca

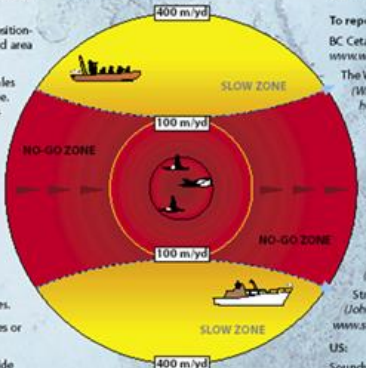
Marine Mammal Monitoring Project (M3)
(Victoria and Southern Gulf Islands):
(250) 480-2656 or www.salishsea.ca










Straitwatch
(Johnstone Strait and Northern Vancouver Island)
www.straitwatch.org

US:
Soundwatch Boater Education Program
(Washington State, Haro Strait Region)
(360) 378-4710 or www.whalemuseum.org

NOAA Fisheries Northwest Region
www.nwr.noaa.gov

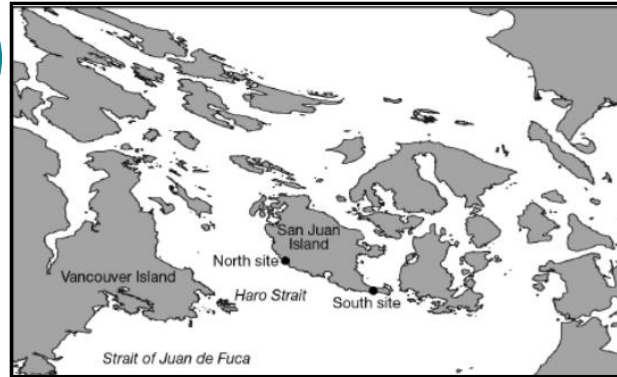
NOAA Fisheries, Office of Protected Resources
www.nmfs.noaa.gov/pr/MMWatch/MMViewing.html



Land-Based Theodolite SRKW Behavioral Study

David Bain (2003-2005)



- Scan sample (Lusseau *et al.* 2009)
 - ↓ Foraging and ↑ travel when boats are within 100 m and from 100 - 400 m of whales
- Focal follow (Williams *et al.* 2009)
 - Changes in respiration rate, swim speed, path directedness, and occurrence of surface active behaviors (SABs) when boats are within 0 to ≥ 400 m
 - ↑ Performance of SABs in response to close approaches by vessels and ↑ vessel presence

Boat-Based Focal Follow SRKW Behavioral Study

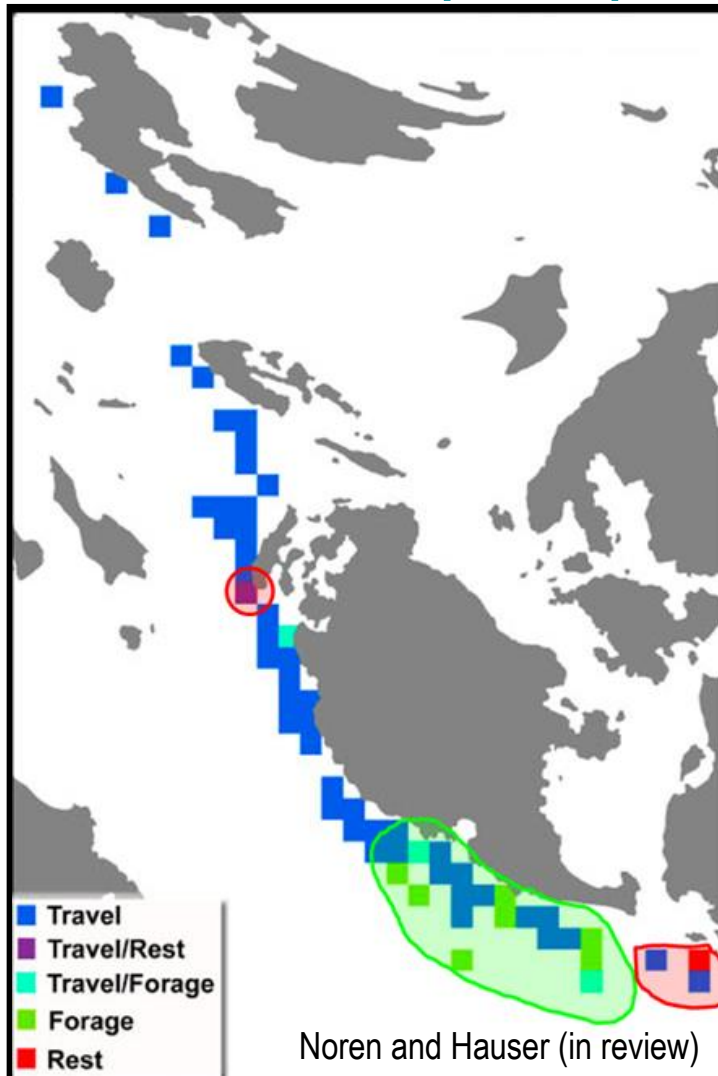
Dawn Noren (2004-2006)



- Spatial and temporal relationships between close approaches by vessels and surface active behaviors (SABs, Noren *et al.* 2009)
 - SAB bouts \uparrow when vessel distance to whale \downarrow
 - Significantly higher proportion of SAB bouts occur when vessels are within 0 to 150 m of whales
 - SAB bouts \uparrow near the time of the closest approach by a vessel

Boat-Based Scan Sample SRKW Behavioral Study

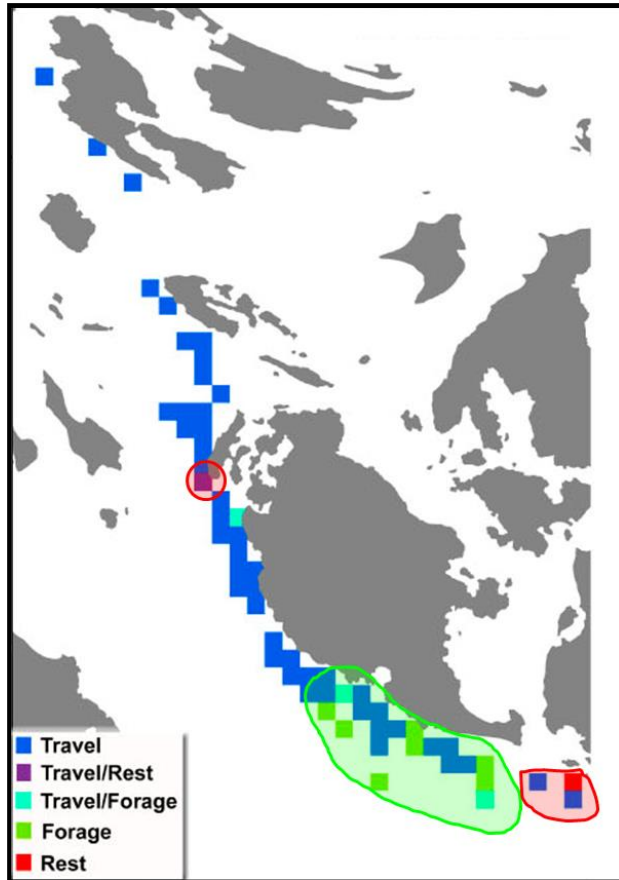
Dawn Noren (2006)



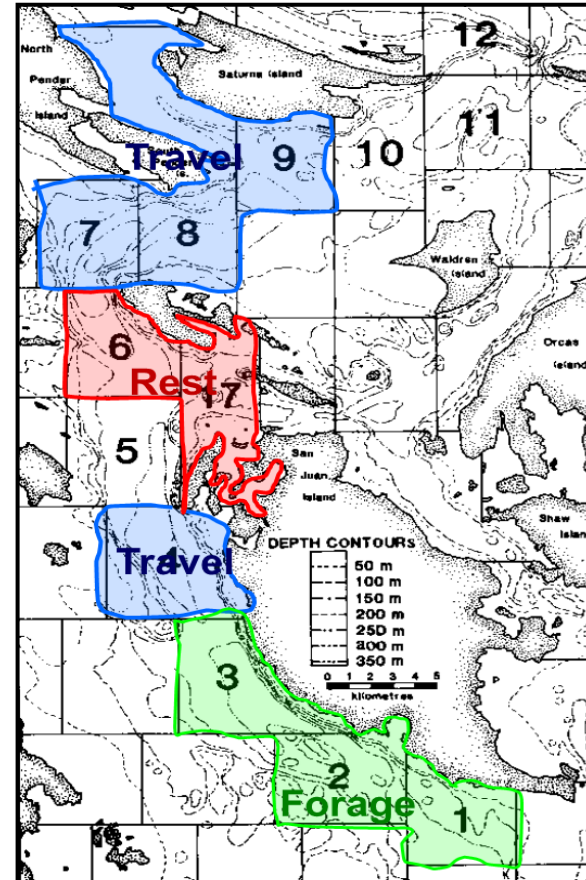
- Some SRKW activity states predominantly occur in distinct locations
 - Rest – 2 locations
 - Forage – Primarily southwest of San Juan Island

Persistent Activity State Hot Spots

2006 (Noren and Hauser in review)



1976-83 (Heimlich-Boran 1988)



Forage: Southwest of San Juan Island

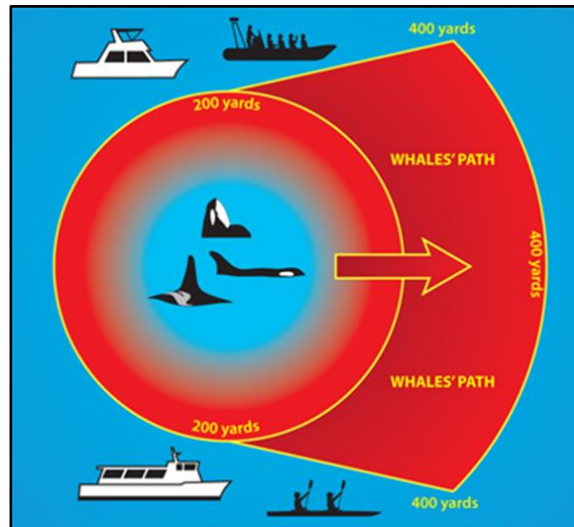
Rest: Northwest of San Juan Island

Research Efforts Resulted in Management Actions

- Common results across studies
 - Various SRKW behavioral changes occur when vessels are within close proximity (0 m to ≥ 400 m)



- Vessel Regulations (2011)



Vessel Presence and Noise

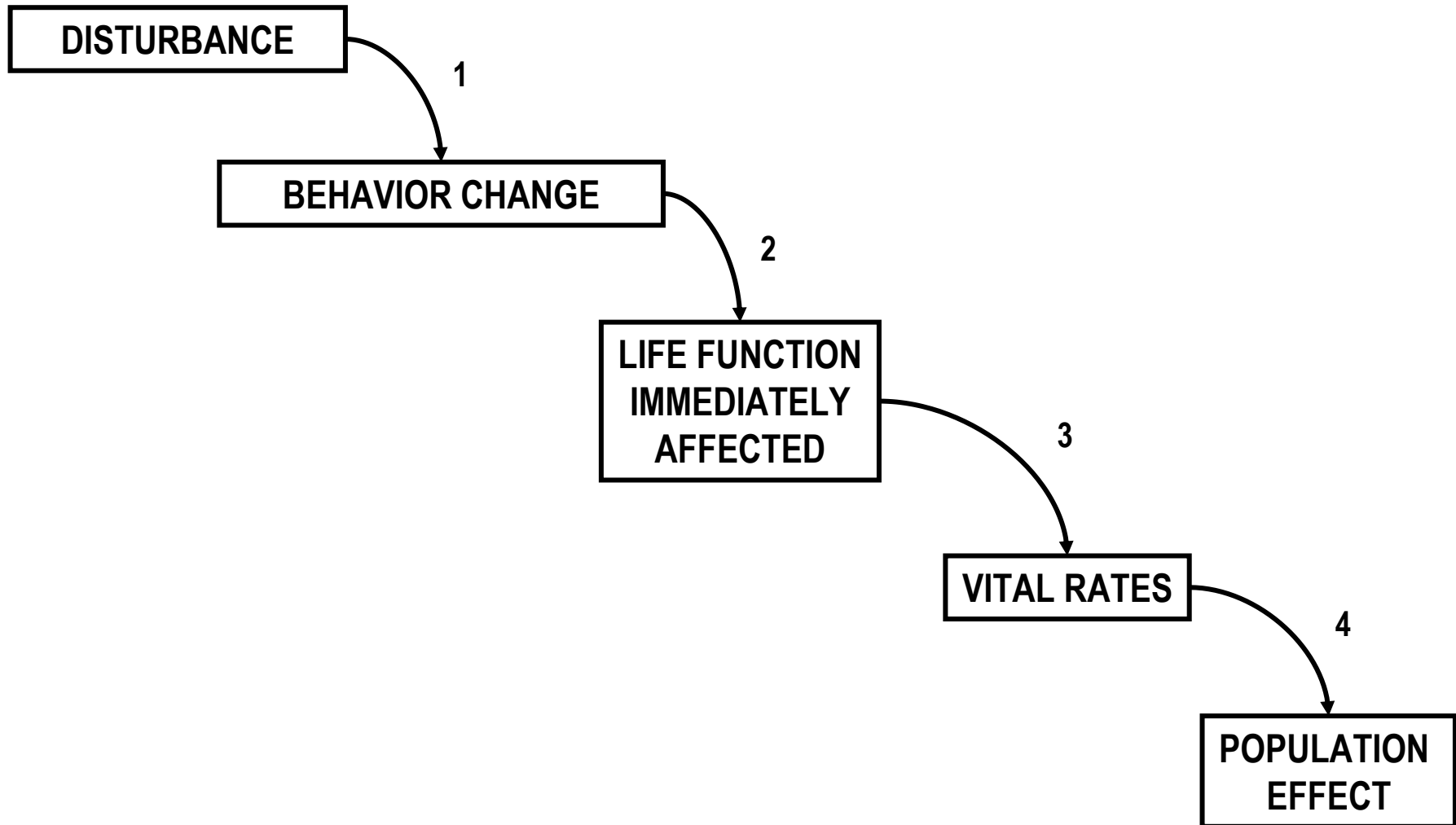


Bioenergetic model to
assess the biological
significance of responses to
vessels

(Noren, Holt, and others)



Population Consequences of Disturbance



Population Consequences of Disturbance

DISTURBANCE

Vessels
(Presence & Noise)

1

BEHAVIOR CHANGE

↑ Surface active behaviors
Changes in swim speed
Switching from forage to travel (↑ swim speed)
Vocal modifications

2

LIFE FUNCTION IMMEDIATELY AFFECTED

Prey intake
-Increased DPERs
-Lost feeding opportunities

3

VITAL RATES

4

POPULATION EFFECT



=



Lusseau *et al.* (2009), Noren *et al.* (2009), Williams *et al.* (2009)

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Population Consequences of Disturbance

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**Vessels
(Presence & Noise)**

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↑ Surface active behaviors
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**Change in
metabolic rate**

LIFE FUNCTION IMMEDIATELY AFFECTED

**Prey intake
-Increased DPERs**



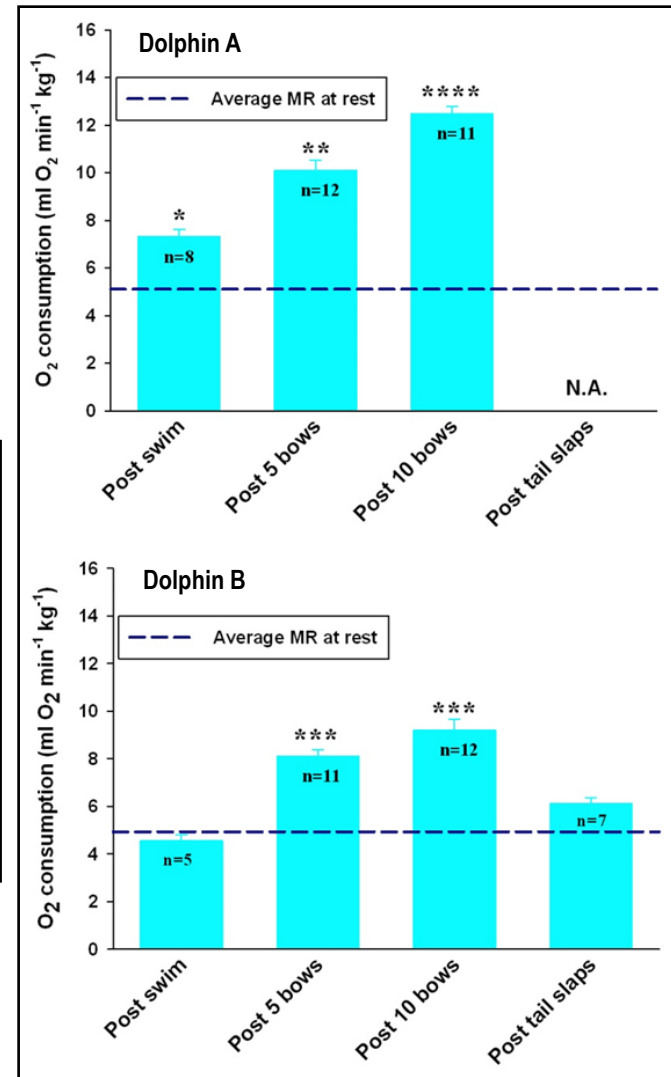
Noren *et al.* (2009), Williams *et al.* (2009)

Energetic Cost of Surface Active Behaviors



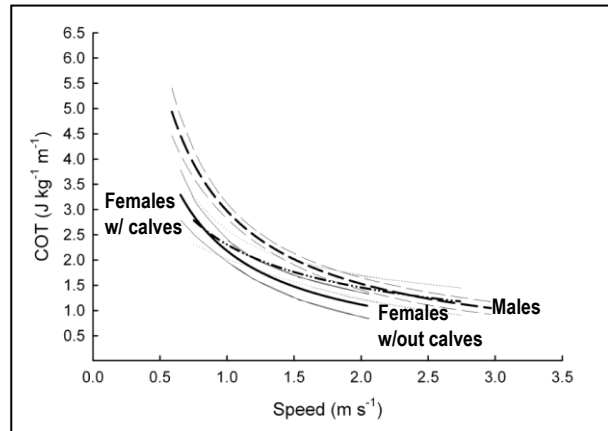
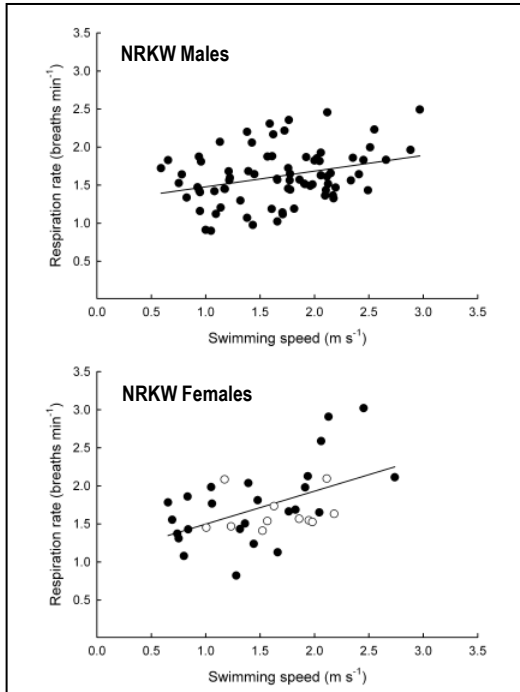
SABs can increase energy expenditure

- Breaches are energetically costly
- Tail slaps are less costly



Noren, Dunkin, Williams (unpublished data)

Energetic Cost of Increasing Swim Speed



Williams and Noren (2009)

**FMR at SRKW forage speed
(1.1 ms⁻¹*)**

**FMR at SRKW travel speed
(2.2 ms⁻¹*)**

**Adult Males
(4434 kg*)**

1153.7 MJ day⁻¹
(7.25 X Kleiber BMR)

1186.1 MJ day⁻¹
(7.45 X Kleiber BMR)

**Adult Females
(without calves,
3338 kg*)**

636.6 MJ day⁻¹
(4.95X Kleiber BMR)

649.7 MJ day⁻¹
(5.05X Kleiber BMR)

* From Noren (2011)

Do Behavioral Responses Significantly Increase Daily Prey Energy Requirements (DPERs)?



=



+



+

Vocal
Modifications

?
=



Conclusions

- Research has directly influenced management actions
 - Vessel regulations (2011)
- Current work assesses energetic impacts of vessel presence
 - Are SRKW DPERs (Noren 2011) significantly greater in the presence of vessels?
- Future work could assess the efficacy of vessel regulations in reducing SRKW behavioral responses
 - Too costly to repeat behavioral studies, given budget restrictions
 - Data collected during DTAG studies might provide insight into changes in activity states, but sample size may be limited





Relevant Peer-Reviewed Publications Funded by NOAA NWFSC

Southern Resident Killer Whale Behavioral Responses to Vessels

- *Lusseau D., Bain D.E., Williams R., Smith J.C. (2009) Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. *Endangered Species Research* 6:211–221.
- *Noren D.P., Johnson A.H., Rehder D., Larson A. (2009) Close approaches by vessels elicit surface active behaviors by Southern Resident killer whales. *Endangered Species Research* 8:179-192.
- *Williams R., Bain D.E., Smith J.C., Lusseau D. (2009) Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. *Endangered Species Research* 6:199-209.

Southern Resident Killer Whale Summer Critical Habitat Use and Potential Marine Protected Areas

- Ashe E., Noren D.P., Williams R. (2010) Animal behaviour and marine protected areas: Incorporating behavioural data into the selection of marine protected areas for an endangered killer whale population. *Animal Conservation* 13:196-203.
- Noren D.P. and Hauser D.D.W. (in review) Surface-based observations can assess activity budgets and fine-scale habitat use by an endangered killer whale population.

Northern Resident Killer Whale Behavioral Responses to Vessels

- Williams R. and Ashe E. (2007) Killer whale evasive tactics vary with boat number. *Journal of Zoology* 272:390-397.

Resident Killer Whale Energetics

- Noren D.P. (2011) Estimated field metabolic rates and prey requirements of resident killer whales. *Marine Mammal Science* 27:60–77.
- Williams R. and Noren D.P. (2009) Swimming speed, respiration rate and estimated cost of transport in adult killer whales. *Marine Mammal Science* 25: 327–350.

*Denotes open access